

The 1987 Newfoundland Oil Spill Experiment

An Overview

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Abstract

A joint Canadian-United States exercise involving the intentional spilling of approximately 20,000 gallons of specially-treated crude oil was conducted off Newfoundland in September 1987 to evaluate the containment and recovery capabilities of three state-of-the-art booms and skimmers. As part of the exercise, data were collected on a specially-instrumented oil spill boom in an attempt to verify a proposed performance test procedure for open-ocean oil spill booms. A visco-elastic chemical additive was used, after the equipment evaluation was completed to enhance recovery operations. Additional observations were made on the persistence of spilled oil slicks in advanced sea states. The containment and recovery effort was one of the most successful on record and was conducted in winds and sea states commonly thought to be beyond existing capabilities.

Introduction

An intentional oil spill of 18,000 U.S. gallons was conducted on September 24, 1987, offshore of St. John's Newfoundland to evaluate the containment and recovery capability of three booms and skimmers. The spill also provided an opportunity to verify a nonpolluting performance evaluation procedure for offshore oil containment booms. The spill was conducted approximately 25 nautical miles east of St. John's. Ocean dumping permit requirements included SSW currents and westerly winds to minimize chance of shoreline contact; water depths of at least 100 meters; the site had to be at least 25 nautical miles from shore, and the area had to be within 2 to 3 hours steaming from St. John's. The center of the area selected was 47 degrees, 40 minutes North and 52 degrees, 03 minutes West.

A crude similar to the typical high wax Grand Banks crude was unavailable. Brent crude from the North Sea was allegedly treated by adding 1 percent slack wax by volume to yield an oil of similar physical properties to the Grand Banks crudes. The modified oil was to have a density of 839.8 kg/m³ and a viscosity of 20 m Pas at 12 degrees C (Ross, 1987a). Recent information indicates that insufficient slack wax was added to reach the 1 percent by volume target level.

Meteorological conditions were recorded on the Canadian Coast Guard (CCG) Cutter "Grenfell" at 15 minute intervals. These include corrected wind velocities and air and water temperatures.

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A wave rider was deployed at the test site but failed to function during the exercise. Consequently, sea conditions were estimated, with reasonable agreement, by various trained observers.

The test plan called for the deployment of three booms as follows: A 250 meter length of the specially instrumented Oil and Hazardous Material Simulated Environmental Test Tank (OHMSETT) boom would be deployed in normal catenary. Approximately 20,000 gallons of treated Brent Crude would be spilled by the command/recovery ship Terra Nova Sea into the catenary. The oil would be held in the boom for approximately 1 hour while freeboard and draft data and visual observations of oil retention were recorded. During this period, 200 meters of the Canadian Coast Guard's RO-BOOM would be deployed behind the OHMSETT boom. The tow speed would be increased to significant loss speed (0.5-1.0 knot). One end of the boom would then be released and the oil discharged into the RO-BOOM. Oil would be held in the RO-BOOM for approximately 1 hour while the oil retention capabilities were observed. The St. John's Coast Guard Vikoma Ocean Pack boom (400 meters) would be deployed behind the RO-BOOM during the observation period. The last procedure involving lost tow speeds would be repeated with the RO-BOOM, and the oil would be released into the Vikoma.

Oil would be retained in the Vikoma for approximately 1 hour. The Terra Nova Sea would then commence skimmer evaluations. Two skimmers, the Framo ACW400, and an innovative Coast Guard Heavy Oil Skimmer (HOS) would be evaluated for 20 minutes each and the remaining contained oil would be recovered by the skimmer with the better performance (Ross, 1987b).

The intent of the OHMSETT boom deployment would be to verify the hypothesis that a boom's ability to contain oil is correlated with its ability to sea keep or comply with wave-induced surface motion. If this hypothesis could be verified and quantified, future performance evaluations of offshore containment booms could be restricted to measuring seakeeping capabilities in a range of sea states. No further spills of the 20,000 gallon size of light and heavy oils would be required, in a range sea states, to evaluate each type of boom. Ocean dumping permits are difficult to obtain and intentional oil spill exercises of this magnitude approach the million dollar funding level. Intentional spills also constitute a risk of potential damage to the immediate environment. Clearly a cost-effective and nonpolluting evaluation procedure for offshore equipment is necessary to develop a predictive capability for the performance of offshore response equipment. Wind conditions desired were sea state 2 to 4, and winds from 10 to 20 knots.

Practice Run - September 21, 1987

The ships and smaller vessels sailed at 6:00 a.m. and proceeded to a location 5.5 miles off Torbay point. The COG Grenfell then deployed the OHMSETT boom and passed one end to the COG cutter 212 which took the boom in tow. The COG cutter 206 then attempted to pick up the trailing end of the boom, a job which took 45 minutes. As soon as the 206 had the end of the boom secured, the two cutters attempted to tow the boom, in a "U" configuration, into a position astern of the Terra

Nova Sea. This resulted in the OHMSETT boom immediately beginning to twist on itself, and 1 hour was lost in straightening the boom. Eventually the boom was positioned relative to the Terra Nova Sea and simulated discharge of the oil was carried out. Data collection, without oil, for almost 1 hour followed.

While the OHMSETT boom was being deployed and positioned, the RO-BOOM was deployed from the CCG Sir Humphrey Gilbert and passed to CCG cutter 214. This procedure took almost 2 hours and, the RO-BOOM was rapidly positioned with respect to the OHMSETT boom because both the Cutter 214 and a Boston Whaler were able to tow the boom at speeds of 5 knots. With the RO-BOOM in position, the CCG cutters 212 and 206 commenced to maneuver, presumably to form a "J." The CCG cutter 206 then snagged the OHMSETT cable in her screws and cut it, disabling herself. This resulted in delay in the exercise while the cable was freed and, because CCG cutter 214 and the Boston Whaler were now approaching closely, the Cutter 212 took the boom and Cutter 206 in tow and cleared the area so as not to impede the exercise.

During the period in which the RO-BOOM was being deployed, the CCG Grenfell deployed the Vikoma boom. Once the simulated oil release was over, the Terra Nova Sea took the other end of the boom and the vessels formed a Catenary. After holding position relative to the RO-BOOM for a period, the ships formed a "J" with the boom and practiced deploying the skimmers.

All ships returned to harbour by 5:00 p.m.

Period Between the Dry Run and the Trial

Several meetings of the senior people involved in the exercise occurred between September 21 and September 23, 1987. It was decided to remove CCG cutter 206 from the exercise. The Boston Whaler was able to tow and hold the boom in sea state 1, but it was recognized that this would be difficult, with oil, in the desired weather. The Newfoundland Fisheries department had provided a vessel, the Bernier, and it was decided to use her and a second chartered OSV to tow the RO-BOOM.

Concern was registered that the weather might, surprisingly, be too calm on September 24, the day which looked best for the actual trial. It was, therefore, decided to interchange the OHMSETT and RO-BOOMS to take advantage of the higher winds and waves expected later in the day.

The long time required to deploy the RO-BOOM from the Sir Humphrey Gilbert led to the decision to deploy that boom from the second OSV, the Triumph Sea. Repairs were carried out on the OHMSETT boom cabling and the boom with instrumentation, was functional by 5:00 p.m. on September 23.

Since the Terra Nova Sea had oil recovery tanks on board, it was decided to dispense with the dumb barge and to release the oil directly from that OSV.

Trial with Oil on September 24, 1987

The Triumph Sea and the Bernier sailed at 3:00 a.m. All other vessels sailed at 4:00 a.m., and everyone was on station by 6:45 a.m. The Triumph Sea commenced deployment of the RO-BOOM enroute and by 7:30 a.m., the boom was ready to receive oil. Once the OHMSEIT boom was deployed, at 8:15 a.m., the oil was pumped into the RO BOOM with supervision from the helicopter and a small boat.

All oil was in the boom by 9:00 a.m.

It was decided to give the news media a chance to view the test from the air and this was done from 9:00 a.m. to 10:00 a.m. During this period, the COG cutters 212 and 214 attempted to pull the OHMSEIT boom into proper position astern of the RO-BOOM and keep it there. Every attempt to move the boom, in a catenary, in the 15 knot winds blowing at the time resulted in the boom twisting. As a result the OHMSEIT boom fell progressively further astern of the RO-BOOM.

At 10:30 a.m. the oil in the end of the pocket of the RO-BOOM was 30 cm thick, the wind was 15 knots, and some splash-over and significant drainage under the boom were occurring. The vessels, therefore, formed a "J" and released one end of the boom to allow the oil to flow into the OHMSEIT boom. The OHMSEIT boom was approximately 1 km astern, and the vessels were having trouble towing the boom in a catenary without the boom twisting. It was, therefore, decided to direct the cutters with the OHMSEIT boom, to the oil, by helicopter, keeping the boom in a straight tow. After 20 minutes, the cutters were adjacent to the thick oil, and, after a further 20 minutes approximately 80 percent of the thick oil was in the OHMSEIT boom. The remaining 20 percent was contained in the Vikoma boom. Data collection on the OHMSEIT boom started as soon as the oil was captured and continued for 56 minutes. The COG cutters then stopped across the path of the vessels towing the Vikoma boom and released one end of the boom. The oil spilled into the Vikoma boom catenary, and one COG cutter trailed the OHMSEIT boom at the throat of the catenary allowing the waves to wash the oil into the Vikoma boom.

The COG Grenfell and Terra Nova Sea towed the oil filled Vikoma boom for approximately 1 hour. During this time, the wind had freshened to 15 knots to 20 knots. The boom was moving at over 1.1 knots relative to the sea, and some oil was being lost (approximately 3 mm thick). The COG Grenfell then attempted to move ahead to form the "J" for the skimmers. Not being very maneuverable, she quickly reached 3.4 knots and the oil was lost.

With the oil now lost, the weather abated slightly. The RO boom was still streaming astern of the Triumph Sea so it was decided that she and the Bernier would form the boom into a catenary and attempt to recover the oil downwind. The helicopter had been lost to the exercise for approximately 1 hour at this time. As soon as it returned, it was refueled and sent up to assist. In the interim a small boat was used to guide the tow vessels into the heaviest portions of the slick. When the helicopter was over the thick oil, it was apparent that the vessels with the RO-BOOM were adjacent to some of the oil and unable to see it. They were, therefore, directed

from the air and small boat, and managed to collect 80 to 90 percent of the thick oil which was on the surface at the time.

Oil was successfully contained and recovery was attempted using the three skimmers on board the recovery-command vessel. The first skimmer, the Heavy Oil Skimmer (HOS), was deployed and no measurable recovery was observed. The oil used was modified by adding petroleum wax so that it would resemble a typical Grand Banks crude oil. This type of oil is uncharacteristic of most crudes in that it possesses low adhesive properties. Therefore, oleophilic skimmers, which depend upon the adhesive nature of the recovered oil, do not perform well with high parafin-based oils. This was again proven with the oleophilic HOS skimmer. The skimmer was recovered after several trained observers were satisfied that the HOS skimmer had had sufficient evaluation time in the contained slick. Problems with the ability of the support arms, used to suspend both the HOS and Framo skimmers, to adjust to the roll of the vessel and short period wave action resulted in both skimmers being frequently submerged so that oil and water were washed into the sump of the skimmer.

The second skimmer the "Framo ACW-400" was deployed. The overall rate of oil recovery of the Framo was 60 gallons per minute with unknown amounts of the recovery resulting from frequent partial submergence.

At this point, it was decided by the On-scene Commander that the skimmer evaluation was complete. Additional measures were needed to ensure recovery of the remaining contained oil because the weather was deteriorating and night was falling. Accordingly, approximately 7 pounds of the visco-elastic agent "Elastol" were spread from an 8-ounce styrofoam coffee cup into the estimated 7,400 gallons of oil and oil water emulsion in the containment boom. Elastol was added because previous research funded by the Minerals Management Service and Environment Canada had shown that the elastic and adhesive properties of the oil could be increased by addition of the agent, thus making the oil more readily capturable with these types of skimmers. The Framo ACW-400 was retrieved from the slick as the "Elastol" was added and because of the operational constraints on the recovery operation, due to the weather and lateness of the day, the skimmer was not redeployed.

The weir-type skimmer, Pharos Marine GT-185, was deployed into the treated slick and recovered near capacity rates of 85 gallons per minute of oil and oil emulsion with no free water. This recovery rate was higher than anticipated and may have been even higher if the oil had been untreated. Treatment significantly increased the viscosity of the oil. The skimmer was removed from the slick, cleaned, and stored on board.

The HOS skimmer was redeployed and failed to function because of a piece of steel in the return pump. The skimmer was recovered, the steel piece removed, and then the skimmer was redeployed.

The HOS skimmer yielded a recovery rate of 50 gallons per minute with a portion of the oleophilic fabric on one of its two drums damaged. Debris was collected at this time in the ventury system used to measure recovery fluid flow rates. The debris may have contributed to the subsequent failure of the HOS skimmer return hose. No flow-rate measurements were taken before the failure. Visual observations on the amount of oil adhering to the oleophilic fabric of the HOS skimmer indicated that recovery rates were significantly increased by the addition of "Elastol."

Operations were suspended because of the advancing sea states and increasing darkness.

An overflight of the area, by helicopter, was carried out during the skimming operation. This revealed a sheen approximately 2.5 by 0.5 nautical miles with 3 patches of brown oil. It is estimated that no more than 260 gallons of oil remained in the thick patches. A further flight 18 hours later showed that only small brown patches and sheen remained, and this was rapidly dispersing.

Lessons Learned or Relearned

- o Thorough proficiency with the recovery equipment to be used is essential.
- Routine practice is required.
- o Large volumes of oil are necessary to realistically evaluate performance of offshore response equipment.
- o The use of helicopters to direct the placement of tow vessels and the use of small vessels to monitor and advise on boom conditions are essential to maximize the efficiency of conventional recovery operations.
- o Accurate measurements of the meteorological and sea conditions are necessary for accurate analysis of the evaluations.
- o The requirements for slow-speed towing and maneuvering of large containment booms necessitate the use of vessels with variable pitched propellers, thrusters, and good seamen in control.
- o It was not possible to form a recovery configuration with two vessels while towing upwind. The third vessel was necessary for recovery in normal catenary.
- o The upper meteorological and sea state limits for downwind containment and recovery were not reached during this test.
- o Upwind collection proved impossible when winds approached 15 knots. This is consistent with many past observations for containment operations conducted upwind.
- o Steps should be taken to avoid loss of contained oil by shipboard discharges such as cooling water impinging upon the slick.
- o Tankage should be available for recovery of several times as much fluid as discharged to account for the oil and water emulsions and free water recovered.
- o Analysis of the correlation of the ability of a boom to seakeep with its ability to contain oil is continuing.

- o Recovery of high wax oils similar to Newfoundland crudes in 10 degrees C water is significantly enhanced by the use of "Elastol."

Disclaimer

Mention of specific products in this paper does not constitute or infer endorsement or acceptance by the Minerals Management Service, the Conservation and Protection, or the authors.

References

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